Applied Research in Oceanography

Ocean Explorer

Module 17

Bayworld Centre for Research & Education

Overview

1 - Coastal field exploration

2 - Use of oceanographic features to explore maps

3 - Application of GIS in oceanography

4 - Buoy monitoring

5 - Activity : Which data do you need ?

Coastal field exploration is a case of **scientific exploration**. Scientific exploration refers to an expedition : an organized trip into unfamiliar regions, in this case for scientific purposes.

A scientific expedition along the coasts can have many different purposes : it can be to check on specific life forms, to collect samples for museums and researchers, to investigate a special phenomenon or even to draw a detailed map of the coast.

Coastal exploration is often done by archeologists as this is where the sunken ships can be retrieved easily. In the old times, ships would follow the coastline and use it as a guide.

Archeologists also look for underwater cities that might have sunk after an earthquake of simply because of the rise of sea level. These are usually near the coastline as they where ports or commerce centres.

A city underwater ?

One the best example of a city lost under water is Thonis-Heracleion, situated in the Mediterranean sea, next to the Egyptian coast. This was once the entry point to the nile, the large river that runs through the Egyptian land.

Scientists think that an earthquake is responsible for its sinking, due to it's unstable foundations. Artefacts brought to the surface indicate that the ancient city was once a massive trading center and bustling port city. Nowadays, archaeologists are still studying it. The conditions that the artefacts have been submerged in for centuries have preserved them incredibly well. More than 60 ancient shipwrecks have been found in the immediate area, along with hundreds of anchors, coins from across the sea, tablets inscribed in ancient Greek and Egyptian, and vast sculptures that were thought to have once adorned the city's temples.

As said before, coastal exploration is not all about archeology. Many other subjects are as important and need to be investigated. One of them is the water turbidity next to the coastal areas, due to human disturbances or not, and its impact on life under water. This subject is of extreme importance as it can predict the extinction of species. Thanks to such studies, we get time to react before the predicted end of the endangered species, and maybe save them.

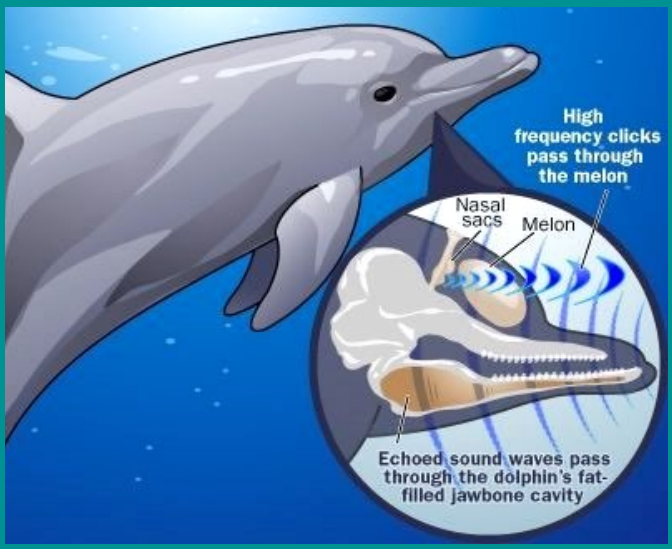
Info +

***Turbidity** is the amount of particules in suspension in water. The more particules, the less clear the water becomes.*

Can turbidity kill species ?

Yes. In Lake Tanganyika, Africa, a few fish species are endangered because of an increase of turbidity in the water. These species, which are endemic to the Lake (i.e. found nowhere else on Earth !), have more difficulties to survive with a higher turbidity.
Why ? Because a large number of particules in water (high turbidity) reduces the amount of dissolved oxygen and raises surface water temperature.

On the other hand, some species need a certain amount of turbidity to survive. Some fish lay their eggs in very turbid waters so that their young can be protected from the predator's view. Other animals, such as the Vaquitas, have adapted to live in turbid waters. They can withstand significant temperature fluctuations and use echolocation to locate their prey in turbid waters where they cannot see !



Echolocation in Vaquitas and Dolphins

2 - Use of oceanographic features to explore maps

The ocean floor is not just a vast expanse of flat rock and sand covered with water. In fact, **bathymetric features** rising from the ocean floor are just as dynamic and diverse as the topography on land. The ocean has mountain ranges, volcanoes, trenches, canyons… It is a three-dimensional habitat !

Many marine species rely on these different bathymetric features to provide suitable habitat, since about 98% of the world's marine species live in, on or just above the seafloor.

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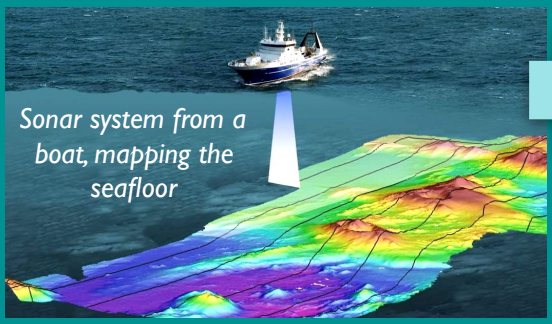
Bathymetry *is the study of underwater depth of lake or ocean floors. It is the underwater equivalent to our land-based topography.*

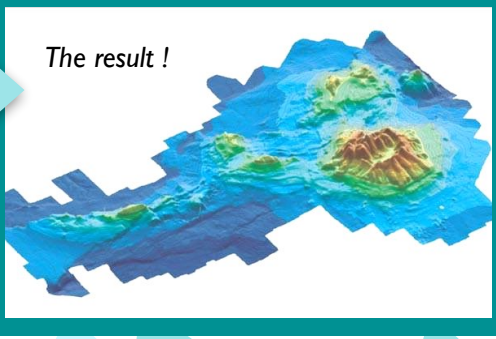
A map of the sea floor

Underwater maps are very difficult to draw. Unlike mapping the land, we can't measure the landscape of the seafloor directly from satellites using radar, because seawater blocks those wavelengths of electromagnetic radiation. But satellites can use radar to measure the height of the sea surface quite accurately. And if there are enough measurements to subtract the effects of waves and tides, satellites can actually measure bumps and dips in the sea surface that result from the underlying landscape of the ocean floor.

But this is not as accurate as what we can do on land. In order to map with precision the sea floor, we use boats equipped with sonar systems. Sonar systems aboard ships can map the ocean floor at about 100 m resolution, but only in a track below the ship, which makes this process very fastidious. Nowadays, only about 20% of the sea floor is fully mapped and documented, which leaves a lot a work ahead of us !



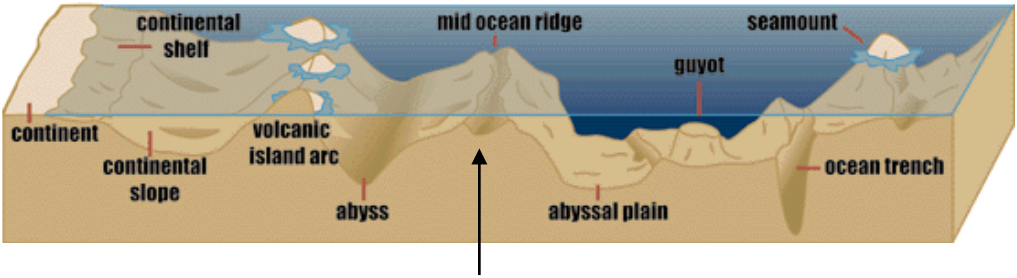
Sonar system from a boat, mapping the seafloor



The result !

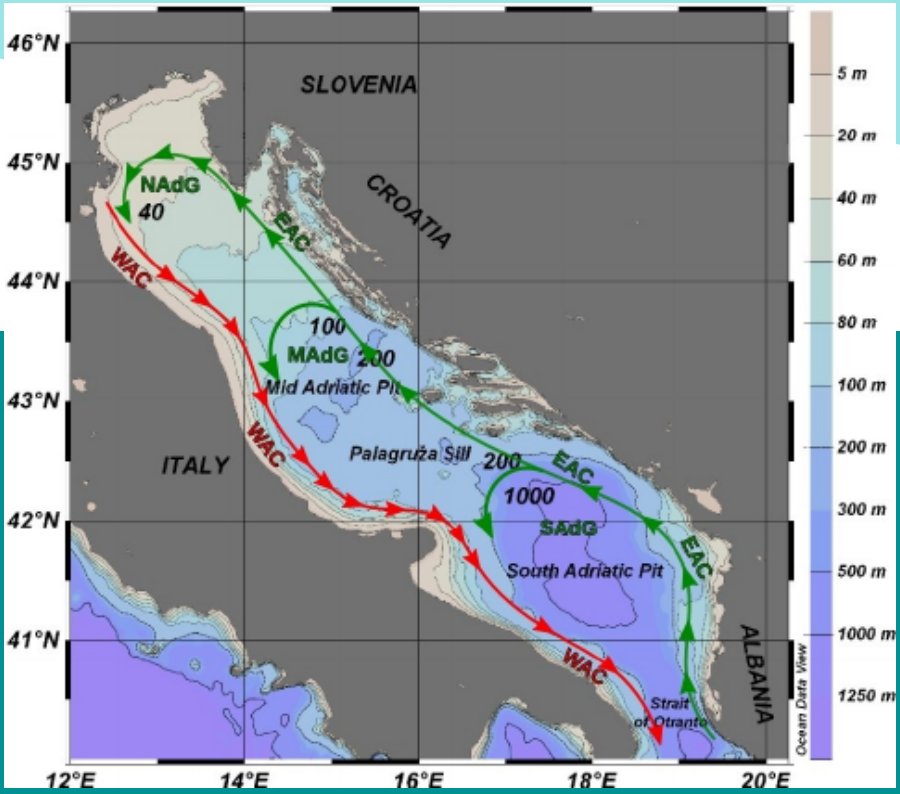
Just as there are three-dimensional structures and features on the seafloor, there are three-dimensional features in the water column as well. These are called **oceanographic features**. Ocean currents circle the globe, transferring heat, nutrients, and life within the water column and across ocean basins. Ocean currents circulate in complex ways that result in highly productive areas rich with life as well as other areas that are mostly devoid of life. Seafloor bathymetry, along with the Earth's rotation, winds, and several other factors determine the directions of ocean currents. These currents not only impact life in the ocean, but since the oceans and the atmosphere are highly interconnected, currents can also influence weather patterns and impact our life on land.

Principal bathymetric features



*The **mid ocean ridge** is made of lava continually poured on the sea floor by the tectonic movements. This ridge marks the limit between two tectonic plates.*

These oceanographic features are very useful when it comes to understand what is happening under water and why. Why is this current going this way ? Why is there such a difference between the life forms in these two locations ? Mapping is just the start of what exploration can give us, there is so much more to discover after the map has been drawn !



Link between bathymetry and currents

The direction and speed of currents is relative to numerous parameters. One of them is the bathymetry. Water will have to go around the sea floor structures, and this is easy to see when the structures are quite large.

In this example, the map represents the Adriatic sea. The currents are in red and green while the bathymetry is indicated by levels of blue. Take a look at the picture and make note of the current position. There are 3 different locations where the green current turns around to join the red current. One can easily see that in the 3 situations, the level of the sea floor suddenly changes, causing the current to turn around.

Keep in mind that these changes in current direction can only be made if the sea level is low. Otherwise, the surface currents will not be impacted by the bathymetry of the sea floor. Only the currents circulating at the level of the structures will be impacted.

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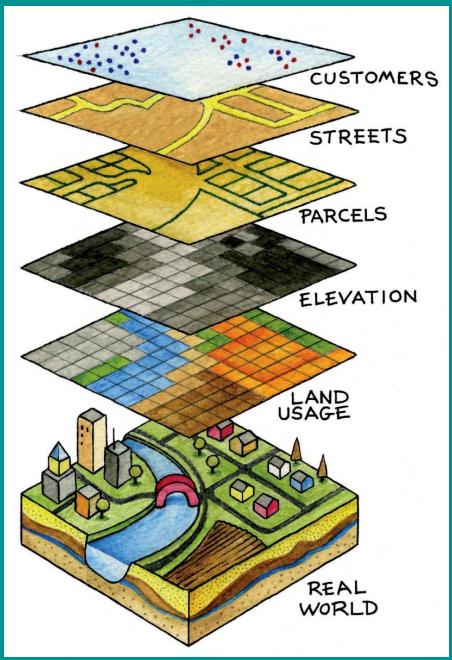
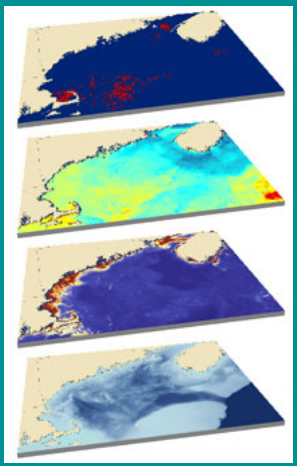
Geographic Information Systems (GIS) : *a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.*

Geographic Information Systems are extremely useful when trying to model the interactions between different biotic and abiotic environmental levels. They are presented in the form of maps that can overlap and sometimes reveal interesting correlations that otherwise we might never think about !

This simple GIS example can show relations between land usage and elevation, and it is a very interesting tool for urbanisation studies.
In fact, any type of layer can be created depending on the information required for the study and the information available of course.



This tool can be applied to oceanography by using different layers. For example, one can decide to show the relationship between the fish school positions at sea and the currents, or the amount of predators depending on the amount of prey !



Whale locations

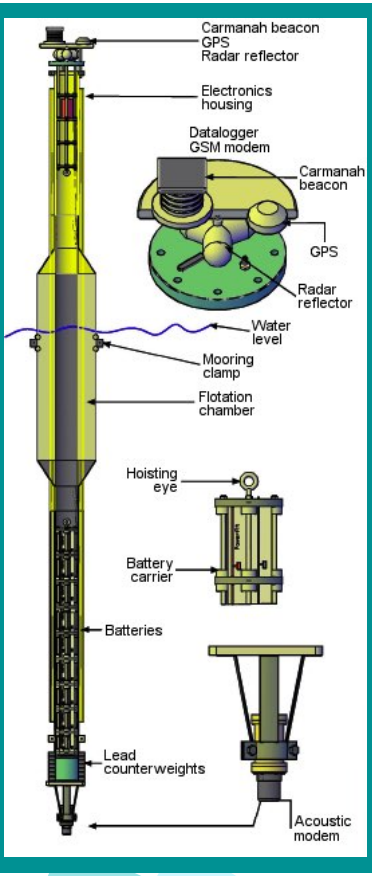
Sea surface temperatures

Chlorophyl

Bathymetry

Research buoys measure oceanographic and meteorological conditions in coastal waters. They are built to resist storms and rough seas and to operate automatically, with only a few check up visits required over a year.

Buoys are very important to monitor day after day currents, sea temperature, weather conditions and sometimes turbidity, pH and oxygen levels. This data, once processed and correlated with other biological data, such as the movements of fish or plankton development in the area, is crucial in understanding how the ocean is functioning.

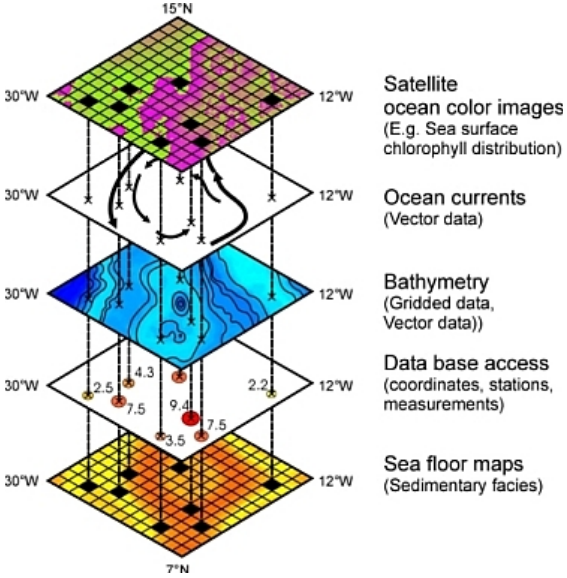


Research buoys carry a lot of sensing equipment, such as GPS systems and temperature probes.

The central part of the buoy is the flotation chamber, so that the buoy doesn't sink. And to prevent the buoy from moving, it is also anchored to the sea floor. But sometimes, when the storms are really strong, the anchor can move or even break, and the buoy gets lost at sea !

Questions

1 - You are a scientist in oceanography. You are given the picture below. What type of system is it ?



2 - Which correlations could you make thanks to the data provided ? Imagine the subjects you could explore should you be given all the data for each slice.

3 - You are told that you need to analyse the relationships between the sea floor structures and the octopus distribution. Can you do it with the data provided or do you need more ? If you are missing something, what do you need ?

4 - It seems that no one can give you any data to cover what you are missing. You will need to go and collect it yourself ! Draft a protocol for an expedition to retrieve the missing data to finish your study.